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HOW TO SPRAY THE AIRCRAFT WAY

a guide for farmers and spray-plane pilots

FARMERS' BULLETIN
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UNITED STATES DEPARTMENT OF AGRICULTURE

FARMERS EVERYWHERE are finding that the application of modern pesticides gets results. Ground equipment is best for some jobs, aerial equipment for others. On the ground or in the air, you can dust or spray. This bulletin is devoted primarily to *aircraft spraying*. It gives farmers a basis for appraising the value of aircraft spraying, and it tells how to plan spraying jobs to suit individual needs. It gives spray-plane pilots information about such matters as equipment, aircraft performance, safety, and calculating pesticide mixtures.

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PLANT PEST CONTROL DIVISION
AGRICULTURAL RESEARCH SERVICE
U. S. DEPARTMENT OF AGRICULTURE

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How To Spray
THE AIRCRAFT WAY

Sprayday Can Be Payday

It's a chill, gray 4 a. m. somewhere in Minnesota or Mississippi, California or Kentucky, or the Carolinas. Far out on a lonely crossroads airstrip, a sleepy pilot shivers and adjusts crash helmet, goggles, and respirator while ground crewmen fill his spray plane's tank with pesticide.

They finish the job. The pilot pulls on his gloves and climbs into the cockpit.

A moment later, the plane wheels slowly out and faces down the runway in the cool, still air of breaking day. Now the motor roars. The plane speeds down the runway, faster and faster. The tail lifts. Wheels spin free as at last the plane pulls up from the ground and heads off in the direction of the spreading green checkerboard of fields it's scheduled to treat.

This is Operation Sprayday. A farmer is fighting insects that threaten his crops. He is spraying the aircraft way.

Too often, insects take the profit out of farming.

It is estimated that insects nullify the productive effort of over 10 percent of our agriculture labor force, causing losses in excess of $4,000,000,000 annually.

Every crop has its insect enemies. We find greenbugs and grasshoppers in the wheatfields, mites and aphids in the pecan groves, wireworms in the cranberry bogs, stink bugs in the ricefields, gypsy moths and spruce budworms in the forests, and so on. All do damage that means loss to the farmer.

Sprayday can be payday for farmers everywhere. It can be *your* payday—if you really need pest-control help and if the spraying job is done right.

Weighing Benefits and Costs

Spraying, from the air or from the ground, *does* cost money. Before you decide it will end all your worries, ask yourself two questions:

1. Do I really need to spray?

When you spray your crops, it's about the same as dosing them with medicine. You wouldn't dose yourself with aspirin, castor oil, or penicillin just for the fun of it. Same way, you don't start a spray program without a good, solid reason.

If pests are leaving you alone this season, if you haven't a real enemy to lick, why throw away your money? Unneeded spraying can even do damage sometimes. Wait till trouble threatens, and *then* spray.

2. Is my crop going to be good enough to make spraying worth while?

If your crop has been hit by drought or flood, or for some other reason looks like a failure, don't go deeper into the financial hole by spraying the crop. Put it this way: If your cabbage patch gets off to a poor start, and you know you will be lucky to get $10 for the cabbage, even without insect damage, then there's no sense in spending $15 on spraying it.

If you check, ask questions, and chart your course before you start, aerial spraying will put money in your pocket. If you can't be bothered, it may cost you instead.

Labor, equipment, spray liquid, your own time—they all cost money. Get full information on spraying before you start. Study this bulletin. Talk to your county agent. Write your State agricultural college or agricultural experiment station. The United States Department of Agriculture will help, and pesticide manufacturers and distributors are eager to lend a hand.

Getting the Job in Focus

Let's suppose you've answered "yes" to the preliminary questions. Now you're ready to consider how you will tackle the spraying or dusting job. Get the job in focus by considering the types of sprays, whether you should use aerial or ground equipment, and whether you should spray or dust.

Types of Sprays

There are three major types of sprays—solutions, emulsions, and suspensions.

Solutions are plain liquids, and do not offer much of a problem.

Emulsions are liquid mixtures that are usually made from oily concentrates and water. "Creaming" of emulsions—partial separation of the mixture upon standing—is a common occurrence.

A suspension is made by mixing a wettable powder with water. The fine particles of powder do not dissolve in the water, but they mix readily with it. Sometimes a suspension, if allowed to stand, will settle out.

Although emulsions have little tendency to clog equipment, they may separate if allowed to stand too long. Both emulsions and suspensions require agitation during spraying operations.

Before pouring a large quantity of pesticide into a spray tank, make sure the equipment will handle it; experiment with a small quantity. Learn all you can about the various liquids you handle. Insecticides, herbicides, de-

foliants, fungicides, fertilizers—you may work with all of them, one time or another.

Aerial or Ground Attack?

Should you spray with aerial equipment or with ground equipment?

That depends on the size of your farm, the lay of your land, the crop to be sprayed, and the insect that you are fighting.

Some insects are in places that are hard to reach with ground equipment. Examples are grasshoppers, when they occur on rough rangeland, and forest pests. In such places you can do a more efficient job with aerial equipment.

Insects on certain truck and field crops are easier to control with ground equipment. One reason is that the pesticide may get further down into the crop when applied from the ground. Another reason: Some insects don't move about; the spray has to land directly on them in order to kill them, and they may escape direct hits from spray applied by plane.

Here are some strong points of aerial spraying:

1. Big outbreaks of insects can be treated with great speed.
2. Insects, diseases, and weeds can be treated without disturbing growing crops.
3. Properly equipped and operated airplanes put out sprays efficiently, and can be used in a wide variety of situations.
4. Planes can keep right on spraying when fields are too wet for ground equipment.

These advantages have strong appeal, but let's sum up from the other side of the fence:

1. It's harder to control spray distribution from planes. Wind or other factors may carry insecticides beyond the field that you want to treat. If the wind is too strong, you may not be able to spray at all.
2. You can often treat small acreages more cheaply with ground equipment.
3. Since most farmers don't own planes, they have to hire commercial operators to spray for them—and that means a cash outlay when cash may be scarce.

If you shy away from aircraft spraying because your acreage is too small to justify the spraying cost, look into the possibility of forming a spraying ring. It may be that you and some of your neighbors can arrange to have several small fields sprayed in one operation.

Spraying vs. Dusting

Is it better to spray or to dust?

There isn't any one answer to this question. But where aerial equipment is concerned, the trend is more and more toward spraying.

Ordinarily, sprays give a more uniform swath, too, since they can be piped and discharged along the span of a plane's wings. And since spray particles usually are heavier than dust particles, they're less likely to drift. That means the plane can fly higher and cover a wider swath. When sprays reach the crop, they stick better than dusts; rain isn't so likely to wash them off plants.

But this doesn't mean dusts should never be used. Some pesticides (fungicides, mostly) are less effective in liquid form. Under some conditions liquids may not penetrate densely growing crops and reach the pests being

treated. So there may be times when you'll have to use dusts, in spite of certain disadvantages.

Don't let your preference run to dusting just because you can see the dust cloud roll into the crop. If we had sharper vision, we could watch the spray droplets showering out much as the dust particles do. The light dust cloud makes a grand sight as it billows far beyond the wingspan, but in some of that cloud there may be too little poison to be effective.

Teamwork and Planning

Aerial spraying looks so easy! First, get a hot-shot pilot with the kind of nerve it takes to hedgehop back and forth 3 feet above a carrotfield. Then buy a battered war-surplus training plane. Pour in a couple of buckets of DDT, and you're ready to go. . . .

Or are you?

The answer, of course, is *no*, you are *not*. For, while it's nice to look on the bright side of things, spraying just isn't that simple. Consider what is involved:

CROPS of all sorts, from spruce trees to garden peas, are attacked by various kinds of

PESTS, which differ in habits and toughness, and have to be controlled by spraying

PESTICIDES, or chemicals—each different, each calling for special preparation, and all applied by

AIRCRAFT . . . light biplanes and monoplanes, multiengine cargo planes, helicopters, or what have you . . . fitted out with

SPRAYING EQUIPMENT . . . tanks, pumps, booms, atomizing devices, controls . . . all serviced by

SKILLED PERSONNEL, both on the ground and in the air.

This lineup shows that aerial spraying is a job for a team, not just a pilot—and it's a job that must be planned.

Who's on the team?

Ground crews load the planes and keep them in condition. Supply men see to it that pesticides and auxiliary equipment are on hand when needed.

There must be someone to organize and supervise the job, to see that all goes well. The pilot or his supervisor usually has this responsibility. He must see that the spraying is done at the right time of day and at the right altitude. He keeps an eye on the weather, which is a big problem.

Behind every spray job is a group of scientists, whether you see them or not. The agronomist contributes his understanding of crops, his training in farm management. The entomologist knows insects and recommends insecticides to be used for controlling them; he also advises on dosages and the most effective spray atomization. The chemist develops new, more potent pesticides. The engineer designs spraying equipment and adapts aircraft for work on the farm front.

Start your planning as soon as you've decided to do business with an aerial-spraying operator.

You'll pay the operator a dollar or two an acre to treat your crop. You can't expect a good job without good planning. Poor planning almost guarantees that you'll end up dissatisfied, and that the operator will lose money.

Planning falls into four main divisions: Preparation, base of operations, supply, and safety.

Preparation takes in everything you have to do to work out a program that fits your individual needs. It includes selection of a pesticide that is known to be effective against the pest that you are fighting, and making sure that the spraying job is done at the right time.

Mexican bean beetles may thrive on poisons that wipe out grasshoppers, and seed-corn maggots need another kind of treatment. Tests aimed at control of aphids on potatoes in Oregon showed that DDT gave poor results—a top of 67- to 73-percent control. Used against beet leafhoppers on Russian-thistle in southern Idaho, it gave 99-percent control.

New insecticides change the control picture from year to year. Until 1950, for example, various poison baits were used against grasshoppers. Then chemical research came up with new insecticides that could be used as sprays. They gave quicker and better results at less cost than anything previously on the market.

To get your money's worth from spraying, you have to hit the insects during the few days or weeks when they are most vulnerable to insecticides. The importance of proper timing can be illustrated by describing the problem that spray crews face when the spruce budworm attacks fir stands in the Northwest.

Spruce budworms usually go through six larval (caterpillar) stages of development. They are most susceptible to insecticides when they are in the early stages, but at that time they are protected by the closed buds of the fir trees.

The effective spraying period, which begins when the buds open and expose the larvae, lasts only about 10 days. But it does not occur at the same time in all areas. It varies with the kind of fir attacked, the elevation, and the exposure.

The problem of when to spray is solved by entomologists who keep a close check on budworm development in each area. The campaign is set for the brief period when budworms in all areas can be wiped out in a single operation. Top control is thus obtained at bottom cost. If this job were done without advance study by experts, odds are that only a small part of an infestation would be wiped out. Repeat sprayings would make the cost soar.

Proper timing has special significance in orchard spraying. If you spray too close to ripening time, you may find too much poison on the harvested fruit. If this happens, the law requires that the fruit be cleaned before it is sold. Cleaning costs money.

The base of operations should be close to the land to be sprayed. If it's too far away, planes will have to carry gasoline instead of payload, and valuable hours of good spraying weather will be wasted.

The runways should be long and smooth. One end, or both ends, should be free of obstructions. Clear away rocks and tall grass; fill in bogs and chuckholes. If a high wind comes up, you'll need to tie down the planes; provide facilities for doing it.

You'll need equipment for loading gas and oil, a source of water, and sheds for storing chemicals. Power pumpers and mixing equipment for sprays are essential; without them, you'll lose time, waste materials, and work under unnecessary handicaps.

SUPPLY is another factor that can make or break a spraying operation. Running out of pesticide in good spraying weather is no joke. Keep at least a 1-day supply in reserve.

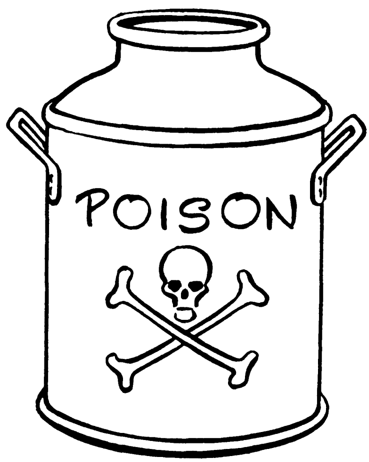
SAFETY has to be considered at every step of the spraying operation.

Not everyone who comes around your airstrip may realize how dangerous pesticides can be. Label all improvised spray-liquid containers with the word "poison," in large letters, and with skull-and-crossbones. Use contrasting colors.

All men working around pesticides should know how dangerous the job can be.

The pilot is the man in greatest danger, and the less contact he has with pesticides—on the ground or in the air—the less likely he is to end up in a heap. Do not expect him to do the work of mechanics or loaders.

Fire is another danger in aerial spraying. A few simple precautions can prevent it. Have plenty of fire extinguishers and shovels at the base. Prohibit smoking near fueling and spray loading sites. Always attach wire grounds to aircraft when adding fuel or spray.



Place mixing and pumping units where planes can't accidentally taxi into them.

Safety pointers for the spray-plane pilot

Always read the precautions on pesticide labels.

Don't let pesticide get on your skin. Change clothing and bathe as soon as you're through work, and have your working clothes washed daily.

Wear protective clothing, including gloves and crash helmet. Install a strong seat belt and shoulder harness, securely anchored to structural members of the aircraft. Always take time before each trip to put them on. Wear a respirator when the job calls for one. . . . When you're handling organic phosphorus insecticides and the like, respirator protection is a must. Not all respirators stop all chemicals. Be sure that yours is of a type that will protect you against the particular spray you're using. Take care of the mask properly; keep it clean; change filters according to directions. . . . See that the men in your ground crew wear protective clothing and—when you're using certain sprays—respirators.

Loading pesticide is a job for the ground crew. Keep away while it's going on.

Never fly through the cloud of spray or dust that you put out in previous passes over the field you're treating.

Install an airtight baffle across the fuselage behind the cockpit to keep out spray or dust that might otherwise be sucked into the cockpit through the rear end of the fuselage.

If you're dusting in an open plane, without a windshield, mount a dust-deflector between hopper and cockpit. It will keep dust out of the cockpit while the hopper is being loaded.

Check regularly for spray-system leaks. Leaking pesticides can poison you, and they can play hob with wood, metal, paint, and fabric. . . . Bead the pipe or tubing to which hoses are attached, so that the hose clamp will give you a slipproof connection. . . . Get the right kind of hose—aviation-grade gas-and-oil hose. Since it's made to withstand aromatic solvents and fuels, it can withstand the solvents ordinarily used in sprays. . . . If you accidentally spill spray liquid on your plane, flush it off with water as soon as possible.

Keep the plane and the spraying equipment clean and in good repair. Do not let spray residue accumulate in cockpit, cabin, or fuselage. Mechanically defective spraying equipment may interfere with the functioning of the plane. . . . Make sure that you can get at all parts of the spray system easily. Install removable panels and inspection plates. If you're planning to handle several types of chemicals (insecticides, herbicides, and fertilizers), you'll want to be able to take out many parts for internal cleaning or for substitution of parts used for just one type of chemical.

Don't try to spray if there's too much wind or thermal air movement. Light a wooden match in the open. If it blows out, be careful—the spray may not go where you want it. . . . Drifting spray can bring damage suits. An herbicide may wipe out a neighbor's crop. An overdose of DDT sweeping down on the orchard across the road at the wrong time may force an apple-grower to wash all his fruit before

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shipping it to market. . . . If you're treating a small field bordered by crops that spray can damage, you may have to hold off until the weather is calm. But if you're working over a big wheat acreage, you may be able to take a chance on a little more breeze.

When things go wrong, you want to be sure you can get rid of your spray load—fast! Install a quick-tripping dump valve. . . . The ratio between the cross-sectional area of the dump valve in square inches to the tank capacity in gallons should be at least 1 to 10. It should be so installed as to prevent blowback into the fuselage. (See "Air Vent," p. 17.)

Pump-propeller blades, if metal, fly off sometimes unless they are designed especially for this kind of work. When that happens, loss of a blade may set up such a severe vibration that the pump assembly tears lose—or a flying blade may damage the plane.

Stick to aircraft standards of workmanship and material when you install spraying equipment. Don't try to keep equipment in place with baling wire. Avoid makeshifts. . . . Don't overload airframe structural members.

The Airborne End

Almost everything that will fly—even blimps—has been tried for crop spraying. Pest-control jobs—some spraying, some dusting—keep more than 5,000 planes busy in the United States.

If you have a choice as to the kind of craft to hire, the main thing to consider is the job you want done. Points to think about include:

How big are your fields?

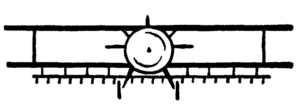
How close are they to landing strips?

What kind of country will the plane have to fly over?

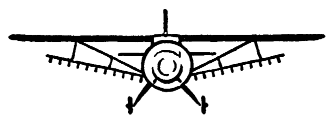
Can the plane carry a big enough load to hold down costs?

Is it fitted with the proper spraying equipment?

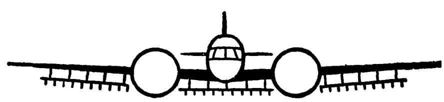
In general, four types of planes are at work on crop-spraying projects:



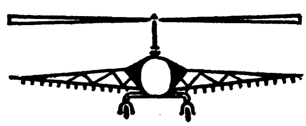
Biplanes, like the Stearman.



Monoplanes of the Cub type.



Multiengine planes, like the Douglas DC–3.



Rotary-wing craft—the helicopters.

All have their advantages and disadvantages. A good many of those in use today are converted war-surplus training planes, which are cheap and easy to handle.

Light planes are well suited to most jobs in farming country. They can be bought and operated at relatively low cost, they maneuver well in tight quarters, and, in an emergency, they can be landed in pastures and roads.

Aircraft especially designed for agricultural uses are being manufactured. Most of them offer special safety features and increased utility.

Spraying rangeland or a forest usually involves greater ferrying distances and larger acreages than spraying crops. For such a job, large planes have distinct advantages over light planes—longer range and bigger payload.

Helicopters also have a place in the sprayday picture. They are more expensive than light, fixed-wing aircraft, but sometimes they can make up for it by their ability to take off and land straight up and down, without a runway. This saves mileage and time, and makes it easier to handle small, hemmed-in fields. Other advantages are that poor flying visibility handicaps helicopters less than it does fixed-winged aircraft, and when flown slowly the downwash from the rotors helps to push the spray deep into the crop.

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No matter what plane you choose, it will carry spraying equipment that belongs to one of two general types. In one type the equipment includes pumps that discharge the pesticide from the plane. The other type lets gravity do the work, the way a sprinkling can does.

Most experts think that pumps do the better job. Without some pressure behind the spray, it's hard to get an even, controlled flow and good atomization.

There is a bewildering variety of spraying equipment. Dozens of different systems and devices have been developed, each with its own strong points and weaknesses. When making a choice, it's a good idea to keep in mind this basic question: Is this the equipment that will get the pesticide onto my crop in the most efficient way?

In general, good equipment should—

1. Spray out the pesticide from the plane at a uniform rate.
2. Provide for an adjustable rate of discharge, so that crops get the right number of gallons of spray per acre.
3. Spread the liquid in as wide a swath as possible beneath the plane.
4. Avoid putting down too heavy a deposit in the center or at the edges of the spray swath.

A spray outfit ordinarily has—

1. A tank, to hold the pesticide.
2. A pump, to move it out.
3. A piping and control system, to carry the right quantities of liquid from the tank to the boom.
4. A boom-and-nozzle assembly that atomizes the liquid—that is, breaks it up into the right-sized spray particles, so that it can be spread properly.

Special jobs may call for special apparatus. Designs are changing constantly. The main thing for you, as a farmer, to remember is that spraying is a technical job. If you're not sure that the man you plan to hire has the right equipment, step right up and ask some questions, both of the operator and of your county agent.

If you own a plane and want to handle the spray job yourself, you can buy spraying rigs, complete, for some of the popular makes of plane. They can be removed readily.

If You're an Operator . . .

What kind of plane is best for you?

By now, it should be obvious that there just isn't any one clearcut answer to that question. You need to consider your finances, experience, and local situation, and the kind of work you'll be doing. The main thing is, *don't* promise or expect the impossible from any single type of aircraft.

A small plane will lose you money on a forest job if it's a hundred-mile run from the nearest landing strip to the spot to be sprayed. A large, fast plane simply isn't cut out for low-level work over tiny truck farms.

What kind of spraying equipment should you install in the plane?

Get versatile equipment. You want to be able to handle as many kinds of spray jobs as possible within your plane's limitations. Get equipment that can put out different types of sprays, produce droplets of different sizes, and discharge the liquid at different rates.

SPRAYS. Any time you install apparatus that won't let you put out all the major types of sprays—solutions, emulsions, and suspensions—you're stacking the cards against yourself. Get equipment that will handle all three.

DROPLET SIZE. The size and uniformity of the spray droplets may mean the difference between profit and loss.

Fine sprays are best for killing insects in flight and for penetrating dense foliage. But wind and thermal air currents may cause them to drift badly.

Large droplets drift less. They stick to plant surfaces and have long-lasting effectiveness. But if too large, they may be wasteful or may injure foliage.

You can make sure of the size of the droplets produced only by making actual field tests. General formulas aren't practical.

Droplet size is increased by—

1. Decrease in airspeed.
2. Increase in the viscosity (thickness) of the spray liquid.
3. Increase in flow rate of the spray liquid.
4. Decrease in pump pressure.
5. Decrease in mechanical breakup of the liquid as it's sprayed out.
6. Facing nozzles rearward.

DISCHARGE RATE. It's commonsense, profit insurance, to set up your equipment for high output. Many jobs require only a gallon or two of pesticide per acre. But some require much more. You may be sorry if you install piping and a pump that are just large enough for ordinary work.

You're better off every time to refuse a job for which your planes and equipment aren't suited. Your success depends on good will and good service. Poor work or unduly high charges kill repeat business.

You'll find more information on spray equipment in the later sections of this bulletin. If, after reading it, you have specific questions on the type of aircraft or equipment, send your inquiry to the Plant Pest Control Division, Agricultural Research Service, United States Department of Agriculture, Washington 25, D.C.

Spray-Plane Piloting

Since the early 1920's, when commercial use of aircraft for insect control began in this country, many special techniques of spray-plane piloting have been developed. The trick is to lay down exactly the right dosage of pesticide with as few passes as possible. If the plane makes too many circuits, costs go up and time is wasted. If it makes too few, coverage isn't even and the pests aren't killed.

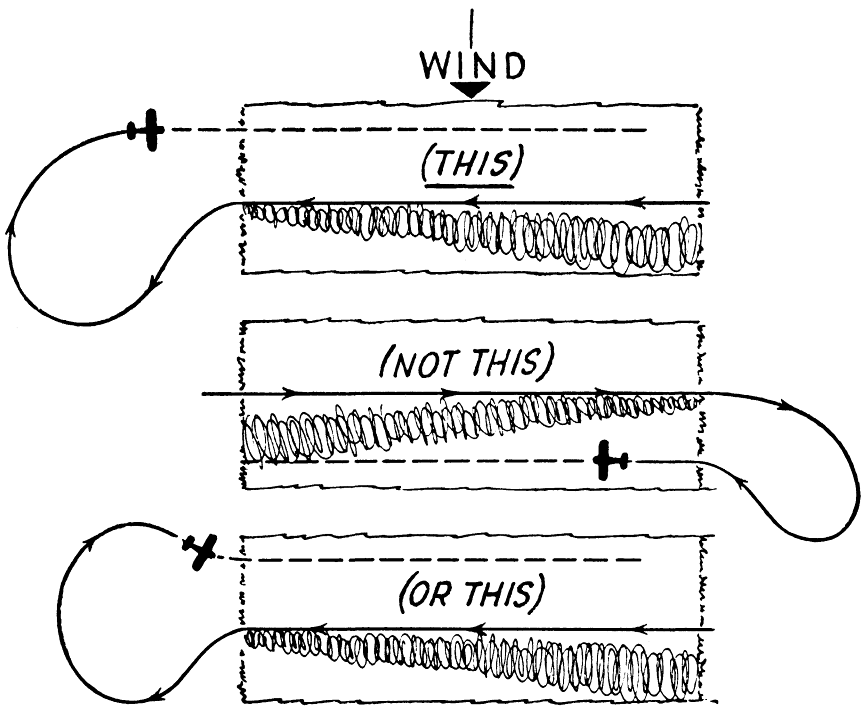
Standard practice in spraying fairly flat, rectangular fields is to follow a grid pattern. The pilot flies back and forth across the area in parallel lines. He holds the distance between the flight lines the same as the effective swath width of the spray plane.

Swath width depends on altitude, wind, plane, and equipment. Measuring it requires field tests. The part of a swath that receives approximately the recommended per-acre dosage of pesticide is called the effective swath.

If You're an Operator . . .

For safety's sake, pilots should fly crosswind, and should move upwind on each successive pass so that there's no chance for the poisonous spray to blow back on the plane.

When feasible, start the turnaround at the end of the spray run with a 45-degree climbing turn *downwind,* over the land adjoining the part of the field



already treated. Then level off and reverse the turn 225 degrees. As you come around, orient yourself and line up for the next run. Then, with power reduced, let down to spraying height and start the new pass.

Be sure to fly long enough on the downwind leg of the turn to allow room to complete the 225-degree swing without crowding or arriving too far upwind to start your next run. The aim is to avoid making tricky turns to get into position.

If the 45-degree starting turn is made *upwind*, you may have to crowd the 225-degree turn and cross your slipstream to start the next run. This should be avoided.

When the country is rough and the area to be sprayed is irregular in shape, the grid pattern doesn't work so well. The rule under these conditions is to fly either along the contours or downslope. Upslope flying with a heavily loaded plane is tempting fate.

Mark hazards, obstructions, and landmarks on your map before you start spraying. If adequate landmarks are lacking, flags should be put down to mark the fields or areas to be sprayed.

Spraying and the Law

Don't neglect the legal aspects of a spraying job. Both the farmer and the operator may be liable for damage to neighboring property.

See your insurance man before you start. He can help you avoid many of the legal entanglements that sometimes arise.

Check State and Federal laws pertaining to agricultural aviation. Be sure your information is current. Many old laws have been changed in recent years, and new ones are continually being enacted.

If you're an operator, you know whether there's a law in your State requiring you to provide workmen's compensation coverage. No matter what State you live in, you may be required to provide such coverage if you enter into a contract with a Federal or State agency.

Some operators insure for property damage, chemical damage, and public liability. It not only protects them; it also helps them get contracts with smart farmers.

With certain chemicals, consider the hazards of drift when the wind is frisky. If your work is in an area surrounded by potential lawsuits—hold it! Wait for calmer weather or it may cost you money. Even a slight wind may carry the chemicals to surrounding crops. Here's where chemical-damage insurance comes in handy.

One of the best forms of insurance is courtesy. Take the time and trouble to let owners of adjoining property know that you're planning to spray. They can arrange to protect livestock or poultry that might be panicked by the roar of the plane, or bees that might be injured by the spray.

WHERE TO GET MORE INFORMATION

Crops and pests vary from one part of the country to another. It pays to get information about local conditions before you spray.

You can get pest-control information from county agents, State experiment stations, State colleges and universities, and local stations of the U.S. Department of Agriculture (for certain specialized work only).

A number of State agricultural colleges conduct short courses in pest control, including use of aircraft. Ask the schools in your area about this.

Regional and national conferences, held annually, cover the latest developments in weed and insect control.

There are schools that train agricultural pilots.

The Federal Aviation Agency's district offices are glad to help aircraft operators improve their equipment and efficiency.

Pesticide manufacturers are up to date on pest-control problems throughout the country. Their representatives are usually eager to help operators.

Finally, you can get information on the various agricultural pests and approved control methods from the U.S. Department of Agriculture, Washington 25, D.C.

FACTS AND FIGURES FOR THE SPRAY-PLANE PILOT

Equipment Facts

TANKS

Size

Make it big enough to carry full loads whenever practical. Sprays differ in weight but seldom weigh less than 7 pounds per gallon. Divide by 7, the maximum pounds your plane can safely carry; multiply that by 231 and you have the cubic inches of the tank you need. Always allow additional space for foaming.

Location

The tank belongs as close as possible to the center of gravity. If it is too far from that point, the craft will be tail- or nose-heavy in flight. The tank should be fastened securely to the main structures of the fuselage. A full spray tank is heavy, and can do a lot of damage if it breaks loose.

Shape

Select a tank that is shaped to correspond with the space where it is to be attached. The bottom should be sloped so that the tank will drain completely, both while spraying and while the plane is on the ground.

Material

Of the metals, stainless steel is best, but aluminum and galvanized iron are satisfactory for most of the pesticides commonly used. Molded plastic tanks eliminate the rust and corrosion worry, and are not attacked by the usual chemical solvents.

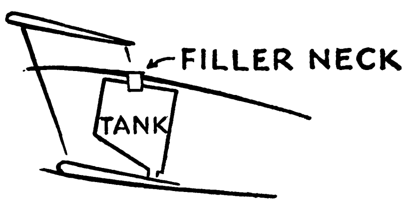
Some operators use removable tank liners of synthetic rubber or plastic—a different liner for each type of spray. This cuts down cleaning time and keeps one spray from contaminating another.

Operators who dust as well as spray sometimes build a liquidtight dust hopper of metal or plastic. With small changes it can also be used as a spray tank.

Filler Neck

Keep it big! The best necks are large enough to let you pour spray liquid into the tank from a 5-gallon can or bucket without a funnel. A big neck will also give you convenient access to the tank interior for cleaning.

Fit the neck with a removable fine-mesh screen to catch sediment. Put it far enough down into the tank, so it won't cause splashing or flooding.



The filler cap should seal tight and open easily. Attach the cap to the neck with a chain. Avoid threaded caps; they're a nuisance. Paint the word "spray"on the plane's surface near the filler neck.

If a combination hopper-tank is used, be sure the hopper door is liquid-tight and locks securely so you will not be showered with pesticide if the plane should nose over in an accident.

Air Vent

Don't put the air vent in the filler cap. Fit a pipe into the top of the tank. Let it project straight up from the tank, then curve downward. Let it project high enough so that it won't overflow from the surge of the liquid in maneuvers or rough air. Loop it down and out through the bottom of the fuselage.

A simple vent in the top of the tank may let spilled spray blow onto the windshield or into your face. Make the vent big enough to let air come in as fast as the spray goes out with the dump valve open. Ordinarily for a 150-gallon load you will need a 1½-inch vent, for a 500-gallon load a 2½-inch vent, for a 700-gallon load a 3-inch vent, etc.

PUMPS

Types

Most operators prefer rotary–gear or centrifugal pumps. Both come in many sizes and makes. Turbine–type pumps may also be used, and in some situations gravity-feed systems are satisfactory. Piston, diaphragm, and rotary–vane units, on the other hand, haven't worked satisfactorily in aerial spraying.

ROTARY–GEAR UNITS. There are several kinds of rotary–gear pumps. All use some combination of gears in mesh to move the liquid. Gear pumps are self-priming, and usually operate at 1,700–2,000 revolutions per minute. They work well with solutions and emulsions.

Wettable-powder suspensions wear the teeth and side wall badly; they may even make the pump "seize."

Since these pumps create positive pressure (as high as 500 pounds per square inch in some types), you'll have to install a relief valve somewhere between the pressure side of the pump and the shutoff valve. Some have an adjustable relief valve incorporated in the pump body.

CENTRIFUGAL UNITS. Since they are not of the positive-displacement type, centrifugal pumps require no relief valve. Their top pressure is seldom above 70 pounds per square inch. They rotate at 3,000–4,000 revolutions per minute.

Some centrifugal pumps have small impellers with wide vanes—to move high volume at low pressure. Others have large-diameter impellers with narrow vanes—to move a lower volume at higher pressure. The best pump for aerial spraying is one somewhere between these two extremes.

The big advantage of centrifugal pumps is their ability to handle all kinds of spray chemicals with minimum wear. However, they're seldom self-priming. You have to mount them lower than the tank or set up some kind of priming arrangement. Also, whereas most gear pumps go either forward or backward, centrifugal pumps push the liquid in one direction only.

TURBINE-TYPE UNITS. Turbine-type pumps, like centrifugal units, handle all sprays without undue wear.

The turbine type offers somewhat higher pressures, and will pump in either direction. But it has no dry lift. You have to mount the pump lower than the tank or prime it by hand.

GRAVITY-FEED SYSTEMS. If you're handling herbicides, liquid fertilizers, or other agricultural chemicals best applied as coarse sprays, or if you're

using special atomizing devices instead of standard nozzles, you may be able to skip pumps and use a gravity-feed system.

The weight of the liquid in the spray tank creates the outlet pressure, but pressure and rate of flow will go down as you empty the tank. You can compensate for this and keep your output constant by installing a float chamber or variable orifice between the tank and the nozzles.

Or—even simpler—vent the tank with a tube that extends through the top of the tank down through the liquid to half an inch above the bottom. The pressure of the liquid in the tank will slow the flow of air into the vacuum area created at the top of the tank as the spray goes out. This keeps the rate of discharge practically constant till the tank is emptied to below the bottom of the tube. A half-inch tube will give enough air to handle a liquid output of up to 100 g. p. m.

With this negative-pressure vent system it is important that the filler cap be airtight. If a dump valve is installed, a separate vent in the top of the tank will have to be opened in conjunction with the dump valve.

Material

Nonrusting metals must be used in pumps. Brass is most common, but aluminum is recommended because it's lighter. Aluminum is used more often in centrifugal and turbine pumps than in the gear types.

Pump shafts should be brass or stainless steel. Get the mechanical type of packing seal; it lasts much longer, and needs less attention, than others.

The stuffing-box variety of packing gland gives fairly good service, but you have to tighten it when there's a leak. Don't tighten the packing nut too hard. If you do, the packing will bind the shaft and cause excessive wear.

Drives

Power sources commonly used to run a spray-plane pump include wind-driven propellers, hydraulic motors, electric motors, and the aircraft engine's accessory drive pad.

WIND-DRIVEN PROPELLERS. For a windmill assembly you need a wood or metal propeller with two to six blades. An automobile fan is dangerous unless well reinforced.

Mount the propeller-and-pump assembly on your plane's landing-gear leg or on a sturdy bracket on the side of the fuselage, or hang it under the fuselage. With the assembly in any of these places, the slipstream from the plane's propeller gives added drive to the propeller that powers the pump.

If you mount the propeller directly on the pump shaft, you'll need a ball-thrust bearing to carry the thrust load from the pump shaft to the pump casing. Without it, the air pressure on the propeller may damage the pump. The propeller's blade pitch will determine how fast the pump rotates.

Put a brake on the pump assembly. Using the brake helps lengthen the life of the pump and the packing glands.

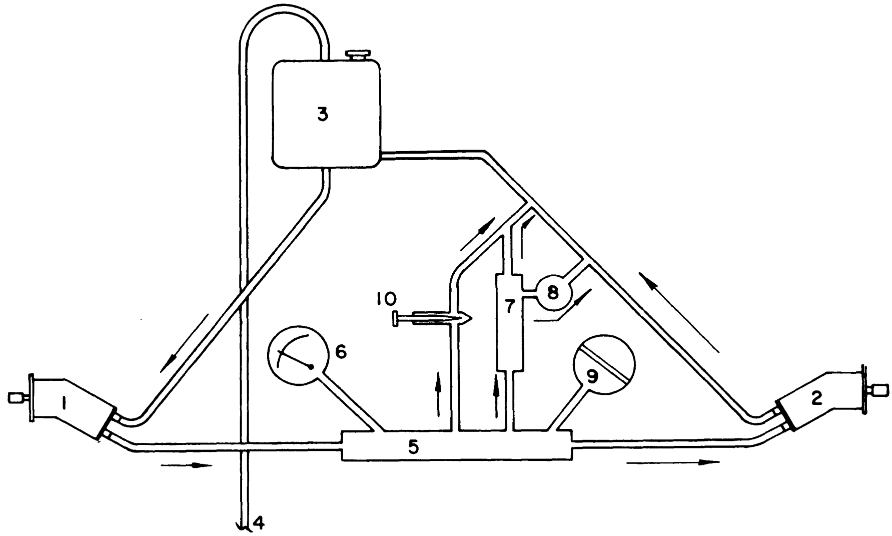
HYDRAULIC MOTORS. Hydraulic systems work well. If your plane has a hydraulic system to operate landing gear or flaps, you may be able to tie your spray pump in with it.

Generally, though, you're better off to install a separate system. Mount a hydraulic pump on an engine accessory pad, then couple a hydraulic motor to the spray pump. To complete the power system, you'll need these items: Hydraulic fluid reservoir (small), accumulator, pressure-relief valve, control valve, and suitable tubing.

You can mount the spray pump entirely inside the fuselage, wherever it fits in best with the rest of the equipment.

If you pick a hydraulically driven spray-pump system, you can start and stop the hydraulic motor by using an unloader valve in the pressure line from the hydraulic pump. This unloader

HYDRAULIC DRIVE SYSTEM



1. Hydraulic pump. 2. Hydraulic motor. 3. Reservoir, 2-gallon capacity. 4. Vent, routed through belly. 5. Manifold 6. Pressure gage, may be attached while adjusting relief valve. 7. Pressure relief and unloader valve, 900 pounds per square inch. 8. On-off valve, controllable from cockpit. 9. Accumulator—50 to 60 pounds per square inch air pressure. 10. Speed-control valve, sharp needle valve, controllable from cockpit, if desirable to regulate motor speed.

valve can be attached to the reservoir and an on-and-off valve attached to it. The on-and-off valve can be controlled remotely from the cockpit. Opening the on-off valve cuts off the hydraulic motor and stops the spray pump. You'll also need a separate control valve for the spray flow.

Light and powerful, this type of hydraulic system is also good for power-feed and agitator drives in dust- or bait-hopper installations.

ELECTRIC MOTORS. Electric-motor-driven pumps have been used for aerial spray work, but usually they're too heavy in relation to power produced.

ACCESSORY DRIVE PAD. If you decide to use an accessory drive pad for power, you can mount the pump on the pad, or connect up with it through pulleys or a flexible shaft. But these systems may have certain disadvantages.

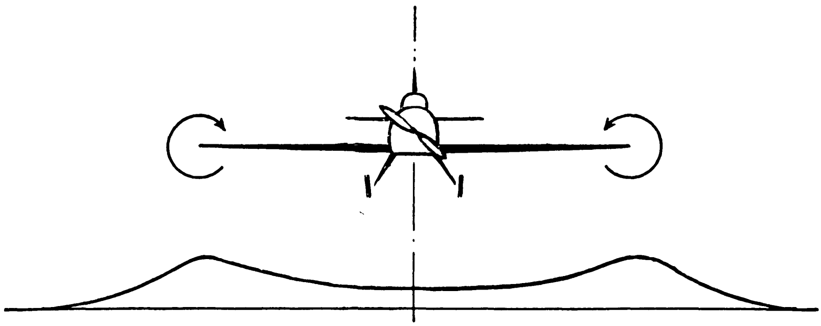
Unless you use a gear-type pump, you'll probably end up with the pump mounted so high that you'll have to hand-prime whenever the pump is emptied.

Getting power through a flexible shaft may be difficult, and it may mean extra maintenance cost.

If you have a direct-mounted or pulley-mounted system, and the pump or the lines spring a leak, there'll be more fire hazard with flammable liquids than there would be if the pump were behind the firewall.

BOOMS, NOZZLES, AND SIMILAR DEVICES

A boom-and-nozzle assembly is the device most commonly used for distrib-



Deposit tendency: Excessive spray in wingtip vortices.

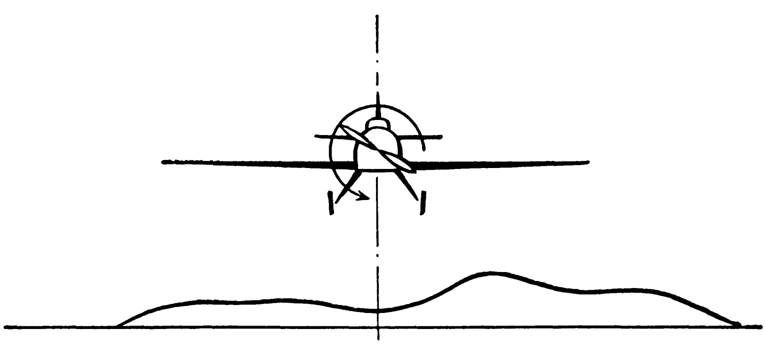
uting and atomizing the spray liquid. The boom is a pipe that distributes the pesticide for release from the plane. Nozzles, which atomize the liquid into spray, are mounted on the boom. Among the alternates are (1) rotating brushes or disks and (2) venturi tubes.

Whether you get a good spray-deposit pattern depends in large measure on the functioning of the selected device.

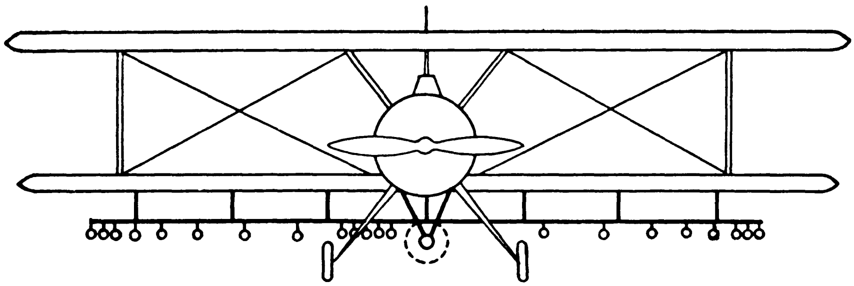
The Boom

Location of the boom varies according to type and make of aircraft.

Biplanes. On biplanes the boom is usually mounted about a foot below the lower wing; it runs parallel to and between the spars. A spray boom mounted 3 or 4 inches behind the trailing edge of the wing works well and offers certain advantages over an underwing boom. The drag is considerably less and there is little danger of the boom snagging brush or tall weeds. Installed on an airplane where the pilot is seated aft of the wing, it allows the pilot to see that the spray system is working and the nozzles are not clogged or leaking. Or if you want to reduce drag and have a cleaner looking rig, you can install the boom in the lower wing panels, with a pipe extended down out of the wing at each nozzle loca-



Deposit tendency: Pattern distorted by propeller slipstream.



Nozzle spacing

tion. (Remember though, that this may make it hard to repair a leaky boom.)

Tests show that if you're spraying 1 to 10 feet above the crop in a biplane, you'll get good results with a boom approximately three-fourths as long as the wing span. In fact, if the boom is much longer than that, too much of the spray may get into the wingtip vortices and spoil the swath pattern.

In spacing the nozzles along the boom, put them progressively closer together as you approach the boom tips. Put a cluster of two or more at each tip.

Group a few nozzles close together 3 or 4 feet to the right of the plane's center line. But on the left side of the line, leave a 3- or 4-foot space without any nozzles; if you put nozzles there, the propeller slipstream will distort your pattern.

Low-wing monoplanes. Boom installation and nozzle spacing on low-wing monoplanes should be the same as on biplanes.

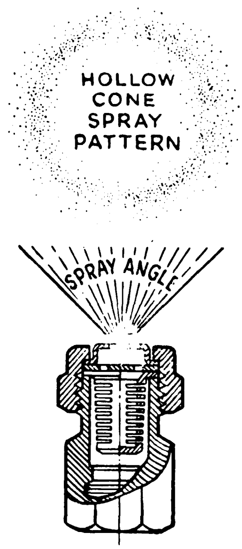
High-wing monoplanes. On strut-braced, high-wing monoplanes the boom can be attached to the struts. It should extend outward and upward so that the outer ends are 2 feet or more below the wingtips.

Some prefer to put the boom parallel to the wing, but this arrangement takes more braces.

Nozzle arrangement should be similar to that described above for biplanes.

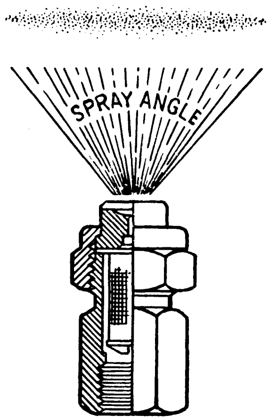
Nozzles

Types. Nozzles that produce a hollow-cone spray or a flat, fan-shaped spray are most widely used for aerial spraying.



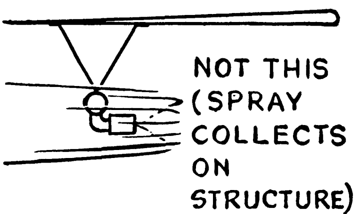
The hollow-cone nozzle will produce droplets more nearly uniform in size than will the flat-spray type. It also tends to wear less.

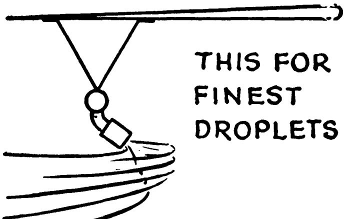
FLAT SPRAY PATTERN

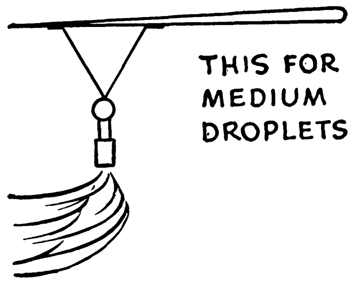


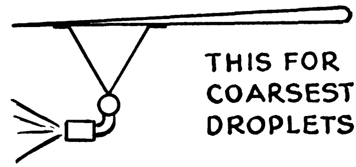
ATOMIZATION. Because the airflow buffets the spray, the degree of atomization produced by a nozzle in flight differs somewhat from the performance of the same nozzle on ground equipment, pressure on the liquid being equal.

The relative angle between airflow and nozzle-output flow also is a factor. A nozzle produces smaller droplets when the orifice outlet faces forward (into the air blast) than when it faces rearward.







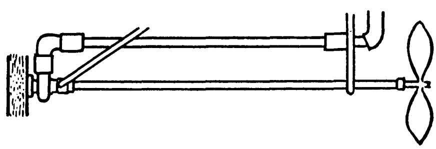


When you set a nozzle so that it faces forward, you should direct it downward enough to keep the spray from being blown back onto the nozzle body or supporting structure. If you don't, some of the spray that collects will run off in large drops. You will be wasting spray, and the drops may injure foliage.

Rotating Devices

Some operators use rotating devices in preference to booms and nozzles. These devices seem to handle a larger variety of liquids, and if you're spraying a liquid with a high sediment content, or one that's especially thick and "gooey," a rotating assembly may be what you need.

The unit consists of a horizontal shaft mounted parallel with the plane's longitudinal axis, with a fan on the front end and disks or a brush on the



other. The shaft is free to rotate in two bearings.

Spray liquid flows through large tubes to the center of the brush or disk unit by gravity. In flight the fan spins

the unit, and the liquid sprays out by centrifugal force.

Venturi Tubes

Some operators mount several venturi tubes along a boom, much as they would mount nozzles. The pesticide is drawn into the tube from a jet by the reduced air pressure and is atomized as in a carburetor.

FLOW CONTROLS

Pipes and Fittings

Use aluminum, stainless steel, or plastic tubing. For connections, stick to dural or brass flare-type fittings, gas-and-oil hose that is resistant to aromatic fuels, and good-quality hose clamps.

Get tubing that is large enough to permit the spray system to keep up with your pump's top output. Lines should have as few sharp bends as possible.

Main-Line Valves

The valve by which you control output should be either a quick-closing gate valve or a cone-type valve. *Don't* use a globe-type valve that takes more than one full turn to operate.

Locate the control valve between relief valve and boom, or between pump and boom if you don't use a relief valve. Put it where you can work it with a push-pull rod, or by a cable-and-spring system. Place the control handle near the throttle. It should move forward to turn spray on and backward to turn spray off.

If your plane has an electrical system, electrically operated solenoid valves or electric-motor-operated valves are especially good. By mounting a toggle or push-button switch on your control-stick grip or control wheel, you can operate the valves with a flick of your finger, without even taking your hand off the throttle.

Nozzle Shutoff Valves

If nozzles are not equipped with check valves or shutoff valves, the liquid will dribble after the flow has been shut off.

You can get nozzles that have a check valve in the body, or nozzles attached to check-valve assemblies. Or you can have a hand-controlled shutoff valve at each nozzle. This calls for a pull cable to open each valve. The cable parallels the boom, outward from the center to the last nozzle on each side of the plane. You operate the cable from the cockpit. The valves close by spring tension when you release the cable.

Another system uses a push-pull rod or tube to open and close the valves.

Other Valves

FOR CENTRIFUGAL PUMP SYSTEMS. If you use a centrifugal pump, the line to the pump inlet should be as large as, or larger than, the pump's inlet port.

You won't need a relief valve to unload pressure with this type of pump. However, a standard globe valve between the output side of the pump and the tank will permit some of the pump's output to be bypassed to the tank for pressure adjustment. The pump flow should be routed back to the tank when it's not flowing to the boom, in order to keep the spray liquid hydraulically agitated—an important point when you're using emulsions or suspensions.

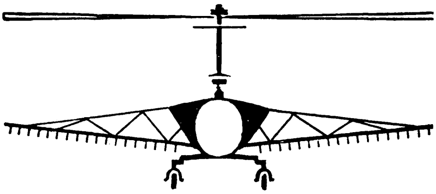
A three-way valve will do the job. Or use a quick-closing gate valve in conjunction with a lightly loaded relief valve or unloading valve installed between the pump and the shutoff valve. The relief line can return the pump output to the tank.

FOR POSITIVE-DISPLACEMENT PUMP SYSTEMS. A positive-displacement pump (gear, vane, or piston pump) needs a relief valve. The relieved spray liquid is piped back to the tank. Set a small vent line with restricting orifice between the shutoff valve and the nozzle check valves, so that you'll get immediate pressure relief in the spray boom when you close the valve. You can connect the other end of this vent line at any point in the main line between pump and tank.

HELICOPTER EQUIPMENT

Load Distribution

One problem in the design of spray equipment for helicopters is balance. The simplest way to solve it is to install two tanks, one on each side of the fuse-



lage directly under the rotor, and as close to the center of gravity as possible. Plan your outfit so that the spray is pumped simultaneously from each tank.

Atomizing Apparatus

Because helicopters usually operate at such a slow flight speed, a windmill won't drive your spray pump properly. Decide on some other means of driving the pump.

A few helicopter manufacturers offer spray boom-and-nozzle assemblies for their aircraft. Some are mounted forward of the nose; others are directly in line with the rotor axis or just a few feet aft.

You can utilize the air blast from the outlet ports of the engine-cooling blower system to atomize the liquid. Direct the flow of the pesticide into the left and right outlet ports through nozzles. The effect is the same as you'd get from two mist blowers mounted on the helicopter. The downwash from the rotors disperses the spray over the crop.

By piping the engine exhaust into the blower outlet tubes so that the air velocity past the nozzles at the outlet ports is materially increased, you get atomization approaching fog. This system gives very fine droplet sizes without using small-orifice nozzles, which clog easily, especially when used with suspensions.

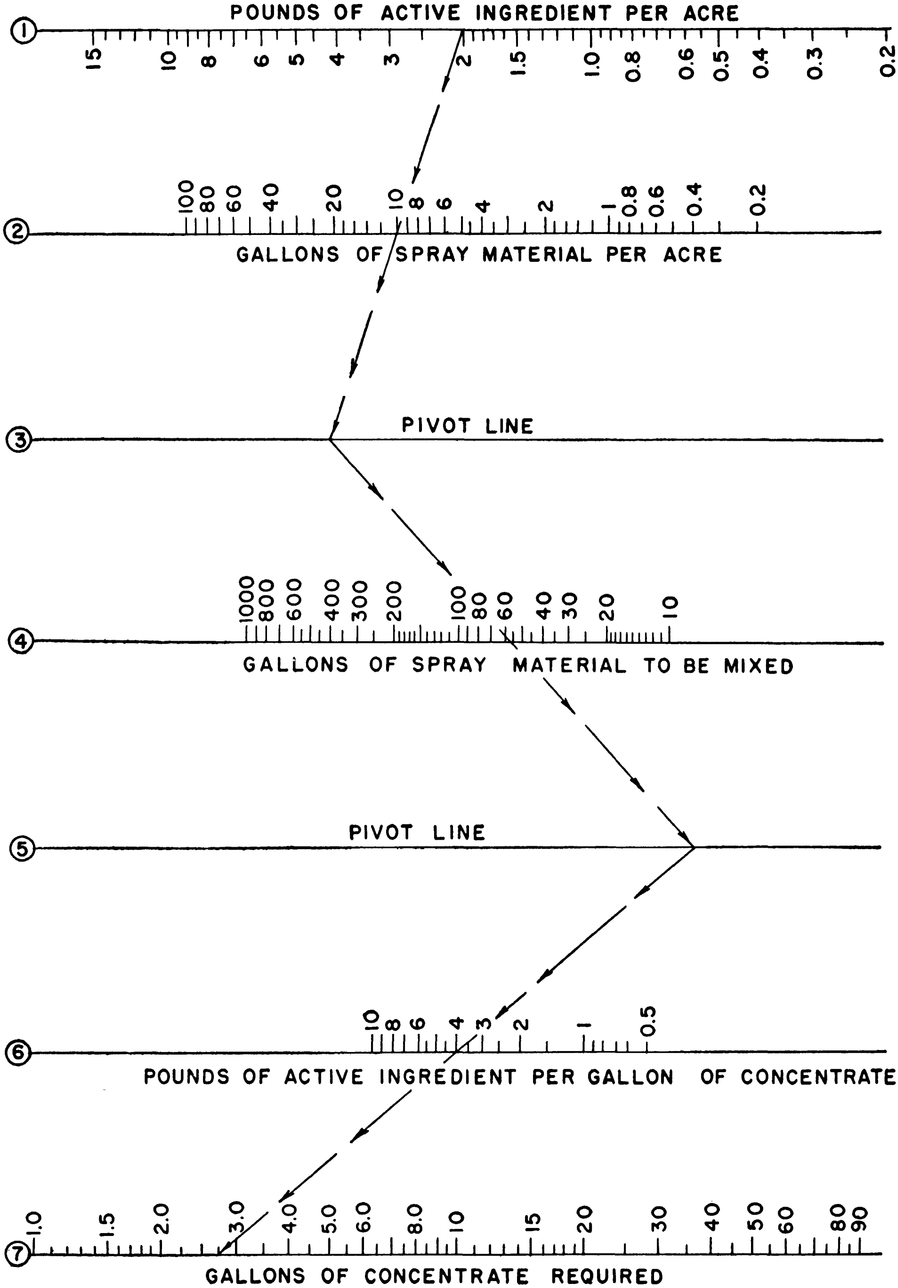
Charts for Calculating Mixtures

To solve mixing problems that arise when working with liquid-concentrate pesticides, use the chart on the opposite page.

EXAMPLE

Suppose you want to apply 2 pounds of active ingredient per acre. The rate of application of spray material is 10 gallons per acre, the tank capacity is 55 gallons, and the concentrate has 4 pounds of active ingredient per gallon.

Using the chart, find 2 pounds per acre on scale 1. Find 10 gallons per acre on scale 2. Draw a straight line through these two points to scale 3; from this point on scale 3, draw a straight line through 55 gallons on scale 4, and intersect scale 5. From this point on scale 5, draw a straight line through 4 pounds of active ingredient per gallon of concentrate on scale 6, and read the gallons of concentrate to be used on scale 7. The amount required is 2.75 gallons.

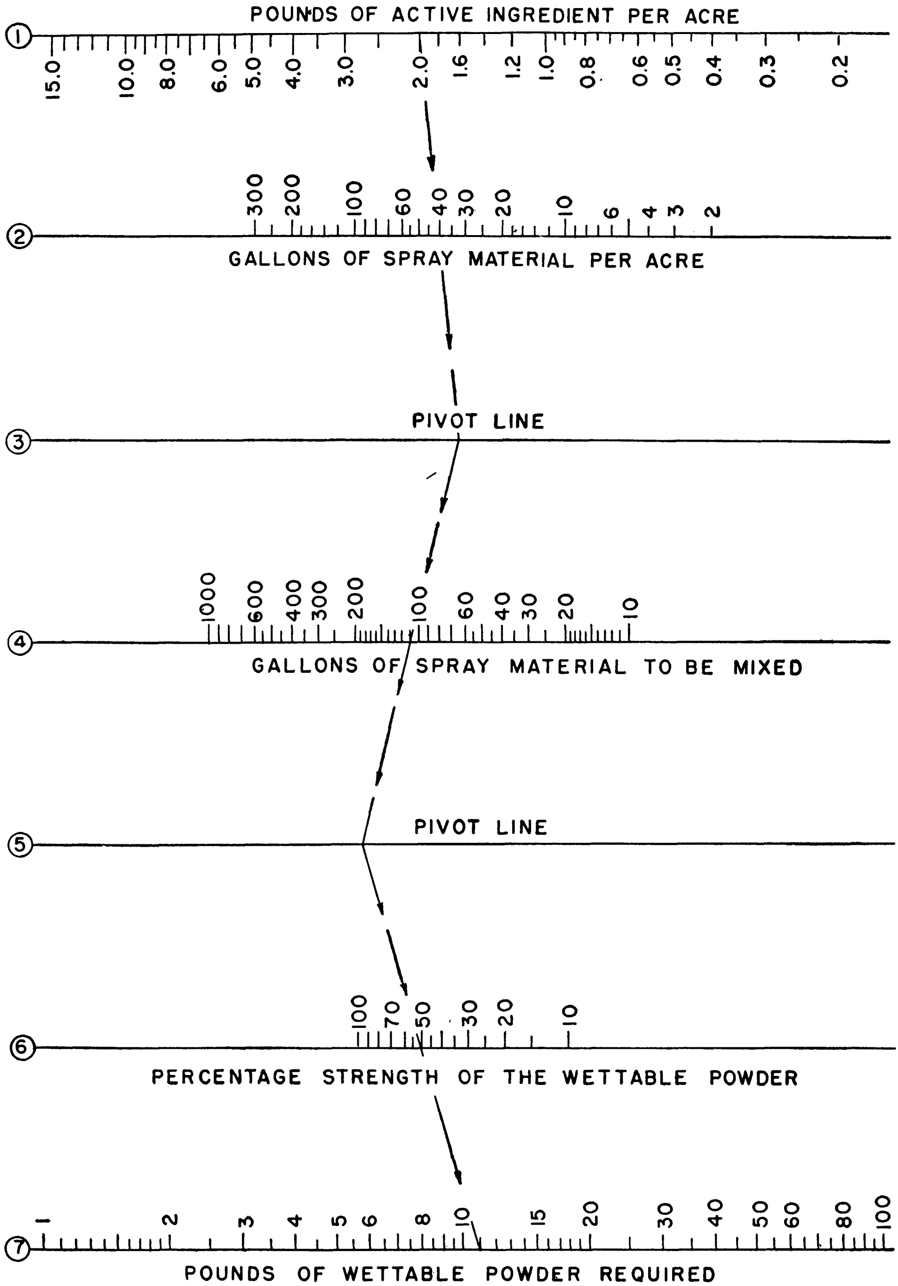

POUNDS OF ACTIVE INGREDIENT PER ACRE
GALLONS OF SPRAY MATERIAL PER ACRE
PIVOT LINE
GALLONS OF SPRAY MATERIAL TO BE MIXED
PIVOT LINE
POUNDS OF ACTIVE INGREDIENT PER GALLON OF CONCENTRATE
GALLONS OF CONCENTRATE REQUIRED

To solve mixing problems that arise when working with wettable-powder pesticides, use the chart on the opposite page.

EXAMPLE

Suppose you want to apply 2 pounds of active ingredient per acre. The rate of application of spray material is 40 gallons per acre, 110 gallons of spray material are to be mixed, and the wettable powder is 50-percent strength.

Find 2 pounds per acre on scale 1. Find 40 gallons per acre on scale 2. Draw a straight line through these two points to scale 3; from this point on scale 3, draw a straight line through 110 gallons on scale 4, and intersect scale 5. From this point, draw a straight line through 50-percent wettable powder on scale 6, and read the amount of powder needed—11 pounds—on scale 7.


POUNDS OF ACTIVE INGREDIENT PER ACRE
15.0 10.0 8.0 6.0 5.0 4.0 3.0 2.0 1.6 1.2 1.0 0.8 0.6 0.5 0.4 0.3 0.2
300 200 100 60 40 30 20 10 6 4 3 2
GALLONS OF SPRAY MATERIAL PER ACRE
PIVOT LINE
1000 600 400 300 200 100 60 40 30 20 10
GALLONS OF SPRAY MATERIAL TO BE MIXED
PIVOT LINE
100 70 50 30 20 10
PERCENTAGE STRENGTH OF THE WETTABLE POWDER
1 2 3 4 5 6 8 10 15 20 30 40 50 60 80 100
POUNDS OF WETTABLE POWDER REQUIRED

Computation of Acreage and Materials

FORMULA: Acres covered $= \dfrac{\textit{Length of swath in miles x width of swath in feet}}{8.25}$

The number of acres in a swath of given width and length can be determined from the chart below.

Example: An aircraft with a 40-foot effective swath treats a strip one mile long. To find the number of acres, follow the 40-foot vertical column down until it intersects the 1-mile line. The answer to the nearest tenth is 4.8 acres. For swath widths other than those shown, interpolate or use combinations of the figures shown.

To determine the amount of pesticide required, multiply the acres by the desired rate of application.

ACREAGE CHART

Swath length (miles)	30′ Swath	35′ Swath	40′ Swath	45′ Swath	50′ Swath	75′ Swath	100′ Swath	200′ Swath	300′ Swath	500′ Swath
1/4	.9	1.1	1.2	1.4	1.5	2.3	3.0	6.1	9.1	15.2
1/2	1.8	2.1	2.4	2.7	3.0	4.5	6.1	12.1	18.2	30.3
3/4	2.7	3.2	3.6	4.1	4.6	6.8	9.1	18.2	27.3	45.4
1	3.6	4.2	4.8	5.5	6.1	9.1	12.1	24.2	36.4	60.6
2	7.2	8.4	9.8	10.9	12.1	18.2	24.2	48.5	72.7	121.2
3	10.8	12.6	14.5	16.4	18.2	27.3	36.4	72.7	109.1	181.8
4	14.4	16.8	19.4	21.8	24.2	36.4	48.5	97.0	145.4	242.4
5	18.0	21.0	24.2	27.3	30.3	45.5	60.6	121.1	181.8	303.0

Spray Drift and Deposit Table

Drop size (microns)[1]	Visual size comparison	Time to fall 10 feet (in seconds)	Drift in 3-m. p. h. wind (in feet)	Drops per square inch if applied at 1 gallon per acre
5	Sea fog	4,050	18,000	9,216,000
33	Cloud	93	409	32,000
100	Mist	11	48	1,152
200	Drizzle	4.2	19	143
500	Light rain	1.59	7	9
1,000	Moderate rain	1.07	5	1
3,000	Cloudburst	.87	4	1/23
6,000	Maximum drop size	.83	3.5	1/182

[1] 1 micron = 1/1000 millimeter. 16 droplets of 100 microns each = 1/16 inch.

Aircraft Calibration

FORMULA: Acres per minute $= \frac{2 \times \text{swath width} \times \text{miles per hour}}{1{,}000}$

The chart below shows the rate, in acres per minute, at which spray of dry material can be applied when swath width and speed of aircraft are known. For swath widths or aircraft speeds other than those shown, interpolate or use combinations of the figures shown. To find the rate of flow in gallons per minute or pounds per minute, multiply the acres per minute figure by the number of gallons or pounds per acre to be applied.

Example: **A 100 mile per hour aircraft has a 40-foot effective swath. Follow the vertical 40-foot column down until the figure opposite 100 miles per hour is intersected. The aircraft would cover 8.0 acres per minute. If 1 gallon of spray is to be applied per acre, the aircraft should be calibrated to disperse liquid at the rate of 1 x 8.0 or 8.0 gallons per minute. If 10 pounds of dry material is to be applied per acre, the aircraft should be calibrated to disperse material at the rate of 10 x 8.0 or 80 pounds per minute.**

ACRES-PER-MINUTE CHART

Speed M.P.H.	30′ Swath	35′ Swath	40′ Swath	45′ Swath	50′ Swath	75′ Swath	100′ Swath	200′ Swath	300′ Swath	500′ Swath
75	4.5	5.2	6.0	6.7	7.5	11.2	15.0	30.0	45.0	75.0
80	4.8	5.6	6.4	7.2	8.0	12.0	16.0	32.0	48.0	80.0
85	5.1	5.9	6.8	7.6	8.5	12.7	17.0	34.0	51.0	85.0
90	5.4	6.3	7.2	8.1	9.0	13.5	18.0	36.0	54.0	90.0
95	5.7	6.6	7.6	8.5	9.5	14.2	19.0	38.0	57.0	95.0
100	6.0	7.0	8.0	9.0	10.0	15.0	20.0	40.0	60.0	100.0
110	6.6	7.7	8.8	9.9	11.0	16.5	22.0	44.0	66.0	110.0
120	7.2	8.4	9.6	10.8	12.0	18.0	24.0	48.0	72.0	120.0
130	7.8	9.1	10.4	11.7	13.0	19.5	26.0	52.0	78.0	130.0
140	8.4	9.8	11.2	12.6	14.0	21.0	28.0	56.0	84.0	140.0
150	9.0	10.5	12.0	13.5	15.0	22.5	30.0	60.0	90.0	150.0

Aircraft Spray Calibration Chart

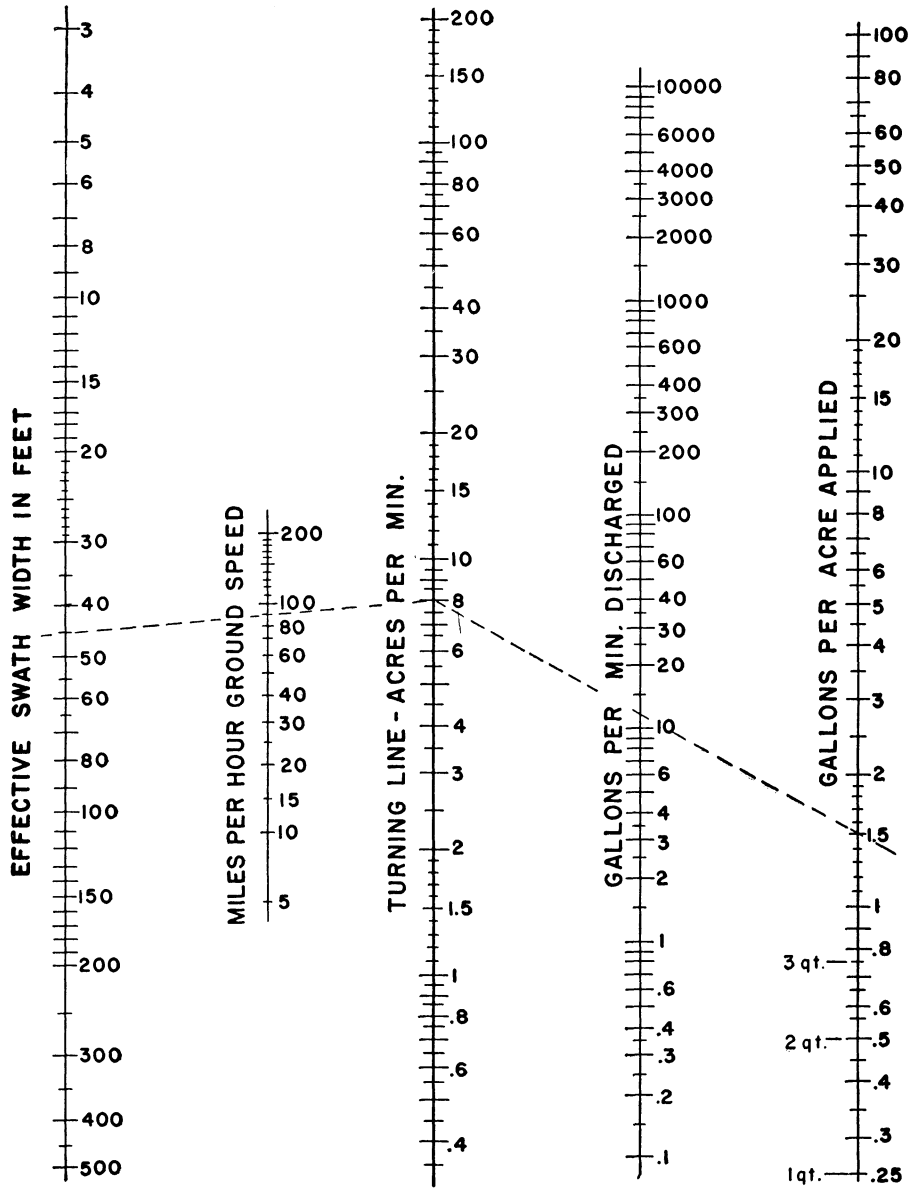
The number of gallons of spray that a system should discharge per minute can be determined by using the chart on the opposite page.

EXAMPLE

Given: Application rate per acre: 1.5 gallons.
Effective swath width: 45 feet.
Ground speed of airplane: 90 miles per hour.

Wanted: Discharge rate in gallons per minute.

Using the chart, find 45 feet on scale 1, and 90 miles per hour on scale 2. Draw a straight line through these two points to scale 3. From this point on scale 3, draw a straight line to 1.5 gallons per acre on scale 5. Where this line intersects scale 4, read the number of gallons per minute that the system should discharge. The required discharge rate is 12 gallons per minute.



Spray Formulas

The number of pounds of pesticide needed to mix a spray containing a given percent of active ingredient can be calculated by using the following formula:

$$\frac{\text{Gallons of spray wanted} \times 8 \times \text{percent of active ingredient wanted}}{\text{Percent of active ingredient in pesticide used}}$$
=Pounds of pesticide to be used.

EXAMPLE

How many pounds of 6-percent gamma BHC wettable powder are needed to make 50 gallons of spray containing 0.03 percent of gamma BHC?

$$\frac{50 \times 8 \times 0.03}{6} = 2 \text{ pounds}$$

The percent of active ingredient in a spray mixture can be calculated by using the following formula:

$$\frac{\text{Pounds of pesticide used} \times \text{percent of active ingredient in pesticide}}{\text{Gallons of spray mixture} \times 8}$$
$$= \text{Percent of active ingredient in the spray.}$$

EXAMPLE

Two pounds of 6-percent gamma BHC wettable powder is mixed with 50 gallons of water. What percent of BHC is in the spray?

$$\frac{2 \times 6}{50 \times 8} = 0.03 \text{ percent}$$

The formulas above work for emulsifiable concentrates, when measured in *pounds*, as well as for wettable powders.

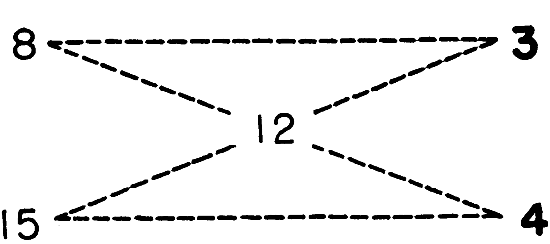
To figure solution percentages, use the formula illustrated below.

Given: Two solutions of 8 percent and 15 percent.

Wanted: A solution of 12 percent.

To find how much of each solution to use, subtract the smaller figure from the larger figure *diagonally*, as follows:

12 from 15=3
8 from 12=4



Now, by reading *horizontally*, you find that 3 parts of the 8-percent solution mixed with 4 parts of the 15-percent solution will give you a 12-percent solution.

State Laws on Aerial Spraying

Laws dealing with pesticide application vary from State to State. As the spraying of herbicides (especially 2,4-D) became widespread, numerous lawsuits arose. It became evident that a uniform State law on spraying was needed. Interested State and Federal agencies drafted a uniform act covering some of the problems that arise from custom application of insecticides, fungicides, and herbicides.

The proposed legislation included provisions relating to—

1. Licensing of custom spray operators in the States in which they sell their services.
2. Written examinations for operators, with ratings issued according to qualifications.
3. Bonding of operators, to make sure that they can handle any liabilities that may arise as a result of their work.
4. Required maintenance of records by operators.
5. Inspection of equipment by State agencies.
6. Compulsory use of, or prohibition of, certain materials or methods.

Many States have adopted laws incorporating all or some of the provisions of the uniform act.

Granting of an aerial pest-control operator's permit may require approval of State agencies that administer laws relating to health, forest conservation, hunting, fishing, and protection of private property. State aeronautical regulations may also be involved.

State authorities may ask operators for detailed reports concerning damage alleged to have been caused by application of pesticides. These reports assist the authorities in determining whether any State law has been violated. Ultimately they are made available to other custom applicators, who can learn from them what practices should be avoided.

Check the laws of your State that concern pesticide application.

Fight Your Insect Enemies

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